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In the Claims:

Please cancel claims 18, 80-81, 86, and 89. Please amend claims 1, 11, 20, 81-84, and 88. The claims are as follows.

1. (Currently amended) A solder composition, comprising a solder alloy,

wherein the alloy is substantially free of lead,

wherein the alloy includes tin (Sn), silver (Ag), copper (Cu), and bismuth (Bi)[[.]],

wherein the tin has a weight percent concentration in the alloy of at least about 90%,

wherein the silver has a weight percent concentration of X in the alloy,

wherein X is sufficiently small that formation of Ag_3Sn plates is substantially suppressed when the alloy in a liquefied state is being solidified by being cooled at to a lower temperature at which the solid Sn phase is nucleated,

wherein the lower temperature corresponds to an undercooling δT relative to the eutectic melting temperature of the alloy,

wherein the copper has a weight percent concentration in the alloy not exceeding about 1.5%, and

wherein the bismuth has a weight percent concentration in the alloy from 0.1% to about 0.2%.

2-4. (Canceled)

5. (Previously presented) The composition of claim 1, wherein the weight percent concentration of the tin in the alloy is in a range of 90% to 95%.

6. (Previously presented) The composition of claim 1, wherein the copper weight percent concentration in the alloy does not exceed about 0.9%.

7-8. (Canceled)

9. (Original) The composition of claim 1, wherein X does not exceed about 2.8%.

10. (Original) The composition of claim 1, wherein X is in a range of about 2.6% to about 2.8%.

11. (Currently amended) A method for forming an electrical structure, comprising:

providing a first substrate and a first solder ball attached to a first electrically conductive pad that is coupled to the first substrate, wherein the first solder ball comprises a solder alloy, wherein the alloy is substantially free of lead, wherein the alloy includes tin (Sn), silver (Ag), and copper (Cu), wherein the tin has a weight percent concentration in the alloy of at least about 90%, and wherein the copper has a weight percent concentration in the alloy not exceeding about 1.5%;

providing a second substrate and a second electrically conductive pad coupled to the second substrate;

coupling the first solder ball to the second pad;

melting the first solder ball by heating the first solder ball to form a modified solder ball; and

solidifying the modified solder ball by cooling the modified solder ball to a lower temperature at which the solid Sn phase is nucleated, and wherein the lower temperature corresponds to an undercooling δT relative to the eutectic melting temperature of the alloy, wherein the solidified modified solder ball is a solder joint that couples the first substrate to the second substrate, ~~and~~ wherein a silver weight percent concentration X_2 in the modified solder ball is sufficiently small that formation of Ag_3Sn plates is substantially suppressed during said cooling, and wherein said cooling the modified solder ball is at a cooling rate in a range of about 1.2 °C/sec to about 3.0 °C/sec.

12. (Previously presented) The method of claim 11, wherein the alloy further includes antimony at a weight percent sufficient to suppress tin pest formation in the solidified modified solder ball.

13. (Original) The method of claim 11, wherein X_2 does not exceed X_{MAX}, wherein X_{MAX} is the maximum silver weight percent concentration in the modified solder ball at which Ag_3Sn plates are thermodynamically barred from being formed in the modified solder ball during said cooling.

14. (Original) The method of claim 13, further comprising determining X_{MAX} as a function of δT from a ternary phase diagram and associated thermodynamic data relating to a ternary mixture of Sn, Ag, and Cu.

15. (Original) The method of claim 11, wherein the first substrate comprises a chip carrier, and wherein the second substrate comprises a circuit card.

16. (Original) The method of claim 15, wherein the first solder ball is a ball grid array (BGA) solder ball.

17. (Original) The method of claim 11, wherein the first substrate comprises a chip, and wherein the second substrate comprises a chip carrier.

18. (Canceled)

19. (Original) The method of claim 11, wherein X_2 does not exceed about 2.8%.

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20. (Previously presented) The method of claim 18, wherein X_2 does not exceed about 2.8%.

21. (Original) The method of claim 11, wherein the copper weight percent concentration in the modified solder ball does not exceed about 0.9%.

22. (Previously presented) The method of claim 11, wherein the weight percent concentration of the tin in the alloy is in a range of 90% to 95%.

23. (Original) The method of claim 11, wherein the second pad is a copper pad, and wherein the

copper weight percent concentration in the first solder ball does not exceed about 0.5%.

24. (Original) The method of claim 11, wherein the second pad is a nickel-gold pad.

25. (Previously presented) The method of claim 11, wherein the alloy further includes bismuth, and wherein the bismuth has a weight percent concentration in the alloy from 0.1% to about 0.2%.

26. (Original) The method of claim 11, wherein coupling the first solder ball to the second pad comprises applying a flux to the second pad and placing the first solder ball in contact with the flux.

27. (Original) The method of claim 11,

wherein coupling the first solder ball to the second pad comprises applying a solder paste to the second pad and placing the first solder ball in contact with the solder paste, and

wherein melting the first solder ball comprises melting the first solder ball and the solder paste by heating the first solder ball and the solder paste, such that the melted solder paste is incorporated into the melted first solder ball to form the modified solder ball, and such that the modified solder ball includes the solder paste within the first solder ball.

28. (Previously presented) The method of claim 27, wherein the solder paste includes a weight percent silver X_P that exceeds the silver weight percent concentration X_1 in the alloy of the first

solder ball, and wherein $X_p - X_l$ is at least 0.2%.

29. (Previously presented) A method for forming a solder composition, comprising:

providing a solder alloy, wherein the alloy is substantially free of lead, wherein the alloy includes tin (Sn), silver (Ag), and copper (Cu), wherein the tin has a weight percent concentration in the alloy of at least about 90%, wherein the silver has a weight percent concentration in the alloy not exceeding about 4.0%, and wherein the copper has a weight percent concentration in the alloy not exceeding about 1.5%;

melting the alloy by heating the alloy; and

solidifying the melted alloy by cooling the melted alloy at a cooling rate in a range of about 1.2 °C/sec to about 3.0 °C/sec.

30. (Original) The method of claim 29, further comprising, prior to said solidifying, selecting the cooling rate that is high enough to substantially suppress said Ag_3Sn plate formation in the alloy.

31. (Previously presented) The method of claim 29, wherein the weight percent concentration of the silver in the alloy does not exceed about 2.8%.

32. (Previously presented) The method of claim 29, wherein the weight percent concentration of the tin in the alloy is in a range of 90% to 95%.

33. (Original) The method of claim 29, wherein the copper weight percent concentration in the

melted alloy does not exceed about 0.9%.

34. (Previously presented) The method of claim 29, wherein the alloy further includes antimony at a weight percent sufficient to suppress tin pest formation in the solidified alloy.

35. (Previously presented) The method of claim 29, wherein the alloy further comprises bismuth, and wherein the bismuth has a weight percent concentration in the alloy from 0.1% to about 0.2%.

36. (Previously presented) A method for forming an electrical structure, comprising:

providing a first substrate and a first solder ball attached to a first electrically conductive pad that is coupled to the first substrate, wherein the first solder ball comprises a solder alloy, wherein the alloy is substantially free of lead, wherein the alloy includes tin (Sn), silver (Ag), and copper (Cu), wherein the tin has a weight percent concentration in the alloy of at least about 90%, wherein the silver has a weight percent concentration in the alloy not exceeding about 4.0%, and wherein the copper has a weight percent concentration in the alloy not exceeding about 1.5%;

providing a second substrate and a second electrically conductive pad coupled to the second substrate;

coupling the first solder ball to the second pad;

melting the first solder ball by heating the first solder ball to form a modified solder ball; and

solidifying the modified solder ball by cooling the modified solder ball at a cooling rate in a range of about 1.2 °C/sec to about 3.0 °C/sec.

37. (Previously presented) The method of claim 36, wherein the alloy further comprises bismuth at a weight percent concentration in the alloy from 0.1% to about 0.2.

38. (Original) The method of claim 36, wherein the first substrate comprises a chip carrier, and wherein the second substrate comprises a circuit card.

39. (Original) The method of claim 38, wherein the first solder ball is a ball grid array (BGA) solder ball.

40. (Original) The method of claim 36, wherein the first substrate comprises a chip, and wherein the second substrate comprises a chip carrier.

41. (Previously presented) The method of claim 36, wherein the weight percent concentration of the silver in the alloy does not exceed about 2.8%.

42. (Previously presented) The method of claim 36, wherein the weight percent concentration of the tin in the alloy is in a range of 90% to 95%.

43. (Original) The method of claim 36, wherein the copper weight percent concentration in the

alloy does not exceed about 0.9%.

44. (Original) The method of claim 36, wherein the second pad is a copper pad.

45. (Original) The method of claim 36, wherein the second pad is a copper pad, and wherein the copper weight percent concentration in the first solder ball does not exceed about 0.5%.

46. (Original) The method of claim 36, wherein the second pad is a nickel-gold pad.

47. (Previously presented) The method of claim 36, wherein the alloy further includes antimony at a weight percent sufficient to suppress tin pest formation in the modified solder ball.

48. (Original) The method of claim 36, wherein coupling the first solder ball to the second pad comprises applying a flux to the second pad and placing the first solder ball in contact with the flux.

49. (Original) The method of claim 36,

wherein coupling the first solder ball to the second pad comprises applying a solder paste to the second pad and placing the first solder ball in contact with the solder paste, and

wherein melting the first solder ball comprises melting the first solder ball and the solder paste by heating the first solder ball and the solder paste, such that the melted solder paste is incorporated into the melted first solder ball to form the modified solder ball, and such that the

modified solder ball includes the solder paste within the first solder ball.

50. (Previously presented) A pre-soldering electrical structure, comprising:

a first substrate and a first solder ball attached to a first electrically conductive pad that is coupled to the first substrate, wherein the first solder ball comprises a solder alloy, wherein the alloy is substantially free of lead, wherein the alloy includes tin (Sn), silver (Ag), copper (Cu), and bismuth (Bi), wherein the tin has a weight percent concentration in the alloy of at least about 90%, and wherein the copper has a weight percent concentration in the alloy not exceeding about 1.5%, and wherein the bismuth has a weight percent concentration in the alloy from 0.1% to about 0.2%;

a second substrate and a second electrically conductive pad coupled to the second substrate, wherein the first solder ball is coupled to the second pad, wherein the first solder ball is adapted to being melted by being heated to form a modified solder ball, wherein the modified solder ball is adapted to being solidified by being cooled to a lower temperature at which the solid Sn phase is nucleated, wherein the lower temperature corresponds to an undercooling δT relative to the eutectic melting temperature of the alloy, wherein the solidified modified solder ball is a solder joint that couples the first substrate to the second substrate, and wherein a silver weight percent concentration X_2 in the modified solder ball is sufficiently small that formation of Ag_3Sn plates are substantially suppressed during said cooling.

51. (Original) The electrical structure of claim 50, wherein the alloy of the first solder ball has a silver weight percent concentration X_1, and wherein X_1 has a predetermined value based on X_2

being sufficiently small that formation of said Ag_3Sn plates is substantially suppressed during cooling of said modified solder ball.

52. (Original) The electrical structure of claim 50, wherein X_2 does not exceed X_{MAX}, wherein X_{MAX} is the maximum silver weight percent concentration in the modified solder ball at which Ag_3Sn plates are thermodynamically barred from being formed in the modified solder ball during said cooling.

53. (Original) The electrical structure of claim 52, wherein X_{MAX} is a function of δT, said function being derived from a ternary phase diagram and associated thermodynamic data relating to a ternary mixture of Sn, Ag, and Cu.

54. (Original) The electrical structure of claim 50, wherein the first substrate comprises a chip carrier, and wherein the second substrate comprises a circuit card.

55. (Original) The electrical structure of claim 54, wherein the first solder ball is a ball grid array (BGA) solder ball.

56. (Original) The electrical structure of claim 50, wherein the first substrate comprises a chip, and wherein the second substrate comprises a chip carrier.

57. (Previously presented) The electrical structure of claim 50, the weight percent concentration

of the tin in the alloy is in a range of 90% to 95%.

58. (Original) The electrical structure of claim 50, wherein X_2 does not exceed about 2.8%.

59. (Original) The electrical structure of claim 50, wherein the solder paste includes a weight percent silver X_P that exceeds X_1, wherein X_1 is the weight percent silver in the first solder ball, and wherein X_2 - X_1 is at least 0.2%.

60. (Original) The electrical structure of claim 50, wherein the copper weight percent concentration in the modified solder ball during cooling is sufficiently small that the pasty range of the modified solder ball during cooling does not exceed about 10 °C.

61. (Original) The electrical structure of claim 50, wherein the copper weight percent concentration in the modified solder ball does not exceed about 0.9%.

62. (Canceled)

63. (Previously presented) The electrical structure of claim 50, wherein the second pad is a copper pad, and wherein the copper weight percent concentration in the first solder ball does not exceed about 0.5%.

64. (Original) The electrical structure of claim 50, wherein the second pad is a nickel-gold pad.

65-66. (Canceled)

67. (Original) The electrical structure of claim 50, wherein the first solder ball is coupled to the second pad by a flux that is applied to the second pad such that the first solder ball in contact with the flux.

68. (Original) The electrical structure of claim 50,

wherein the first solder ball is coupled to the second pad by a solder paste that is applied to the second pad such that the first solder ball in contact with the solder paste; and

wherein the first solder ball is adapted to being melted by heating the first solder ball and the solder pasto, such that the melted solder paste is incorporated into the melted first solder ball to form the modified solder ball, and such that the modified solder ball includes the solder paste within the first solder ball.

69. (Previously presented) A post-soldering electrical structure comprising:

a first substrate; and

a second substrate, wherein the first substrate is coupled to the second substrate by a solder joint, wherein the solder joint comprises an alloy, wherein the alloy is substantially free of lead, wherein the alloy includes tin (Sn), silver (Ag), copper (Cu), and bismuth (Bi), wherein the tin has a weight percent concentration in the alloy of at least about 90%, wherein the silver has a weight percent concentration in the alloy of X_2, wherein X_2 is sufficiently small that Ag_3Sn plates are substantially absent in the solder joint, wherein the copper has a weight percent concentration

in the alloy not exceeding about 1.5%, and wherein the bismuth has a weight percent concentration in the alloy from 0.1% to about 0.2%.

70. (Previously presented) The electrical structure of claim 69, wherein the weight percent concentration of the tin in the alloy is in a range of 90% to 95%.

71. (Original) The electrical structure of claim 69, wherein the first substrate comprises a chip carrier, and wherein the second substrate comprises a circuit card.

72. (Original) The electrical structure of claim 71 wherein the solder joint includes a ball grid array (BGA) solder ball.

73. (Original) The electrical structure of claim 69, wherein the first substrate comprises a chip, and wherein the second substrate comprises a chip carrier.

74. (Canceled)

75. (Original) The electrical structure of claim 69, wherein X_2 does not exceed about 2.8%.

76. (Canceled)

77. (Original) The electrical structure of claim 69, wherein the copper weight percent

concentration in the solder joint does not exceed about 0.9%.

78-79. (Canceled)

80-81. (Cancelled)

82. (Currently amended) The solder composition of claim ~~80~~ 83, wherein the alloy further includes antimony at a weight percent sufficient to suppress tin pest formation in the alloy during a subsequent cooling of the alloy.

83. (Currently amended) ~~The composition of claim 1,~~ A solder composition, comprising a solder alloy,

wherein the alloy is substantially free of lead,

wherein the alloy includes tin (Sn), silver (Ag), copper (Cu), and bismuth (Bi),

wherein the tin has a weight percent concentration in the alloy of at least about 90%,

wherein the silver has a weight percent concentration of X in the alloy,

wherein X is sufficiently small that formation of Ag_3Sn plates is substantially suppressed when the alloy in a liquefied state is being solidified by being cooled at to a lower temperature at which the solid Sn phase is nucleated,

wherein the lower temperature corresponds to an undercooling δT relative to the eutectic melting temperature of the alloy,

wherein the bismuth has a weight percent concentration in the alloy from 0.1% to about

0.2%., and

wherein the copper has a weight percent concentration in the alloy ~~does~~ not exceeding about 0.9%.

84. (Currently amended) A method for forming a solder composition, comprising:

providing a solder alloy, wherein the alloy is substantially free of lead, wherein the alloy includes tin (Sn), silver (Ag), and copper (Cu), wherein the tin has a weight percent concentration in the alloy in a range of 90% to 95%, wherein the silver has a weight percent concentration in the alloy not exceeding about 4.0%, and wherein the copper has a weight percent concentration in the alloy not exceeding about 1.5%;

melting the alloy by heating the alloy; and

solidifying the melted alloy by cooling the melted alloy at a cooling rate that is high enough to substantially suppress Ag_3Sn plate formation in the alloy during said cooling, wherein the cooling rate is in a range of about 1.2 °C/sec to about 3.0 °C/sec.

85. (Previously presented) The method of claim 84, wherein the cooling rate is at least 1.2 °C/sec.

86. (Canceled)

87. (Previously presented) The method of claim 84, wherein the weight percent concentration of silver in the alloy does not exceed about 2.8%.

88. (Currently amended) A method for forming a solder composition, comprising:

providing a solder alloy, wherein the alloy is substantially free of lead, wherein the alloy includes tin (Sn), silver (Ag), and copper (Cu), wherein the tin has a weight percent concentration in the alloy in a range of 90% to 95%, wherein the silver has a weight percent concentration in the alloy not exceeding about 2.8%, and wherein the copper has a weight percent concentration in the alloy not exceeding about 1.5%;

melting the alloy by heating the alloy; and

solidifying the melted alloy by cooling the melted alloy at a cooling rate, wherein the cooling rate is at least 1.2 °C/sec.

89. (Canceled)

90. (Previously presented) The method of claim 88, wherein the cooling rate is in a range of about 1.2 °C/sec to about 3.0 °C/sec.

91. (Previously presented) The method of claim 88, wherein the alloy further includes bismuth at a weight percent concentration in the alloy from 0.1% to about 0.2%.